U.S. Army Research, Development and Engineering Command

Reducing Hazardous Emissions at Anniston Army Depot

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US ARMY RDECOM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Anniston Army Depot

- Anniston Army Depot (ANAD) performs depot level maintenance for combat tanks, tracked combat vehicles, small arms weapons and components, and optical and electronic fire control systems. ANAD has a large production capability, including painting, depainting, surface cleaning, and plating, which makes ANAD a major emitter of hazardous air pollutants (HAPs).

- In order to reduce hazardous emissions at ANAD and to address environmental regulations and mandates, ARL and the NDCEE directly supported efforts at ANAD through the following tasks:

  - Task 0512: Dem/Val of HAP-Free Chemical Depainting Materials and Processes Thrust Area

  - Task 0527-A2: HAP-Free Vapor Degreasing for Critical Weapon Systems Applications

Background and Objective

Task 0512: Dem/Val of HAP-Free Chemical Depainting Materials and Processes Thrust Area

- The U.S. Environmental Protection Agency (EPA) is in the process of issuing new National Emissions Standards for Hazardous Air Pollutants (NESHAPs), one of which will directly impact Department of Defense (DoD) organic coating operations. This military-specific NESHAP, titled "Defense Land Systems and Miscellaneous Equipment (DLSME) NESHAP," will further regulate organic finishing processes and will likely require the modification of process lines to meet the new compliance limits.
- The EPA has identified methylene chloride as the sole organic depainting material of concern in the upcoming military NESHAP. Unless changes are made, ANAD will be significantly impacted by the DLSME NESHAP.
  - ANAD's current process utilizes Pen-Strip® NPX, an acid-activated paint remover that contains approximately 70% methylene chloride
  - Methylene chloride, the only HAP in the mixture, accounts for approximately 92 of the 173 tons (53%) of the HAP air emissions generated by ANAD annually

Approach

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Task 0512: Dem/Val of HAP-Free Chemical Depainting Materials and Processes Thrust Area

1. Quantify the costs of the current methylene chloride chemical immersion depainting operations utilizing NPX

2. Quantify the costs and identify benefits associated with the implementation of alternative HAP-free chemical paint strippers or pollution control equipment and compare those to the baseline process

3. Determine HAP/volatile organic compound (VOC) emissions reductions realized with the implementation of alternative HAP-free chemical strippers

1. Quantify costs of current methylene chloride chemical immersion depainting operations

- Documented current process parameters

PenStrip NPX	70% methylene chloride, 25% formic acid, 5% aromatics
NPX Purchased	64,982 gal/yr (682,038 lbs/yr)
NPX Disposal	324,296 lbs/yr
Vat Capacities	Bldg. 114: One, 2400 gal vat Bldg. 409: Two, 2160 gal vats
Labor	Two 10-hour shifts, 6 days/week
Unit Costs	Procurement, Disposal, Utilities

1. Quantify costs of current methylene chloride chemical immersion depainting operations

Annual Costs for Baseline NPX Depainting Process

Cost Category	Bldg 114	Bldg 409	Total
Labor	$292,500	$390,000	$682,500
Materials	$343,940	$619,093	$963,033
Equipment	$4,900	$4,900	$9,800
Utilities	$3,195	$31,398	$34,594
EHS	$84,293	$151,892	$236,185
TOTAL	**$728,829**	**$1,197,283**	**$1,926,112**

No capital costs were involved in the calculation, as the ongoing NPX depainting process does not require an up-front investment.

2. Quantify costs and identify benefits associated with implementing HAP-free chemical paint strippers or pollution control equipment and compare those to the baseline process

- Identified viable pollution control equipment
  - Alternative scenario based on keeping current NPX process in place
  - Regenerative thermal oxidizer (RTO) and scrubber system selected
- Evaluated three alternative HAP-free strippers
  - D-Zolve 917, D-Zolve 298, Gardostrip Q7900A
  - Estimated annual procurement and disposal amounts using empirical results
  - Included capital costs associated with vat modifications

2. Quantify costs and identify benefits associated with implementing HAP-free chemical paint strippers or pollution control equipment and compare those to the baseline process

Summary of Costs for NPX and Alternative Processes

Technology	Key Ingredients	Capital Costs	Annual O&M Costs	Payback Period (yrs)
Baseline NPX	Methylene chloride Formic acid	$0	$1,926,112	N/A
NPX with Pollution Controls	Methylene chloride Formic acid	$1,913,647	$2,453,047	N/A
D-Zolve 917	Benzyl Alcohol Hydroxy Ethanoic Acid	$277,164	$1,292,556	0.45
D-Zolve 298	Benzyl Alcohol Formic Acid	$277,164	$1,293,919	0.45
Gardostrip Q7900A	Proprietary (44.8% VOC)	$277,164	$1,506,095	0.68

Demonstration Results: Overall Performance

	White Interior* (85% of workload)	Exterior CARC** (15% of workload)
Technology	**Performance vs. NPX**	
D-Zolve 917	Comparable	Required longer dwell times
D-Zolve 298	Equivalent	Slightly slower
Gardostrip Q7900A	Equivalent	Slightly slower

* White Interior Topcoat: MIL-C-22750
** Exterior CARC: MIL-DTL-64159 (water dispersible) or MIL-DTL-53039 (single component polyurethane)

Demonstration Results: B114

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Building 114 NPX and D-Zolve

Mounting brackets coated with MIL-C-22750 (white interior coating)

Result: Comparable/equivalent performance

Demonstration Results: B114

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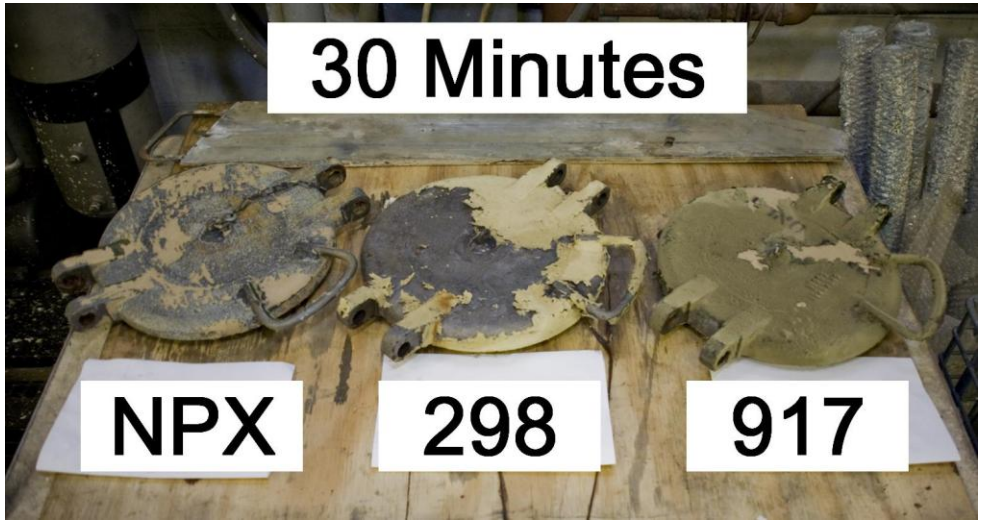
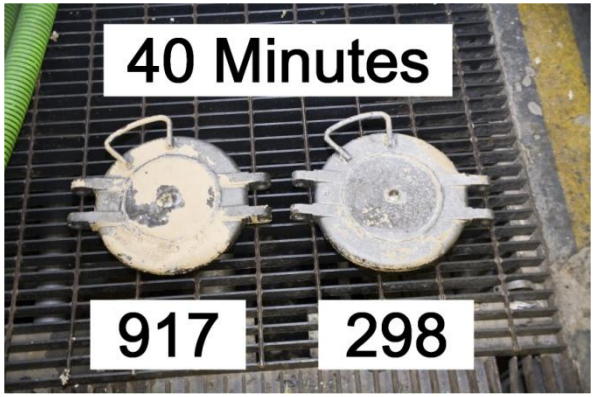
Building 114 NPX and D-Zolve





Filler opening caps coated with MIL-DTL-64159 or 53039 (tan and green exterior CARC)

Result: Part stripped with alternative requires additional dwell time

Demonstration Results: B409

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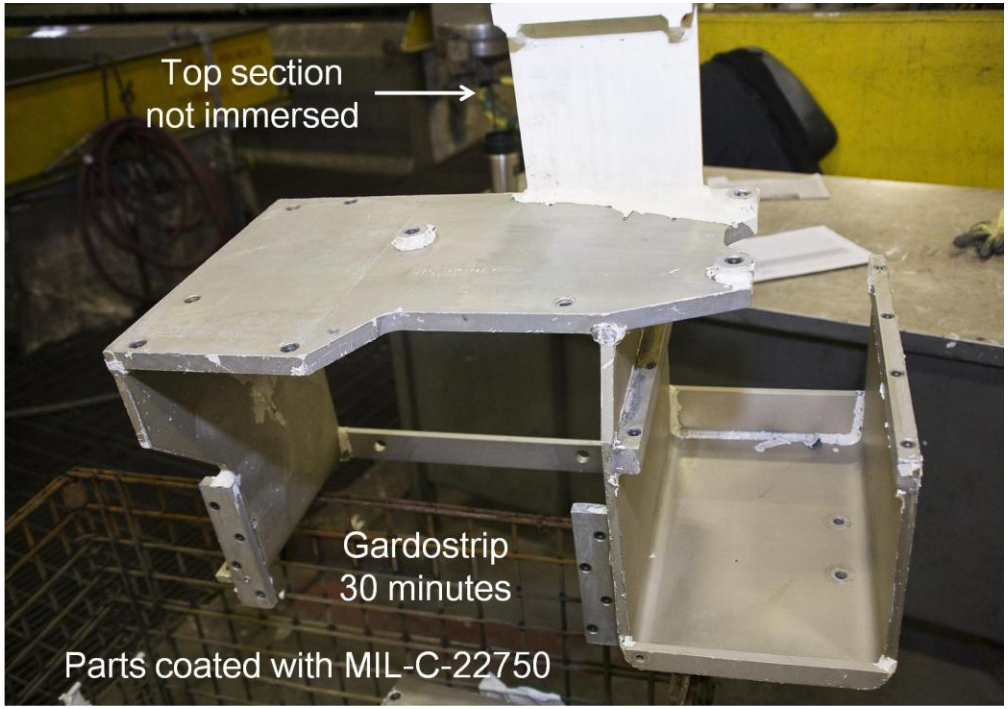
Building 409 NPX and Gardostrip



Electronic components rack coated with MIL-C-22750 (white interior coating)

Result: Equivalent performance

Demonstration Results: B409

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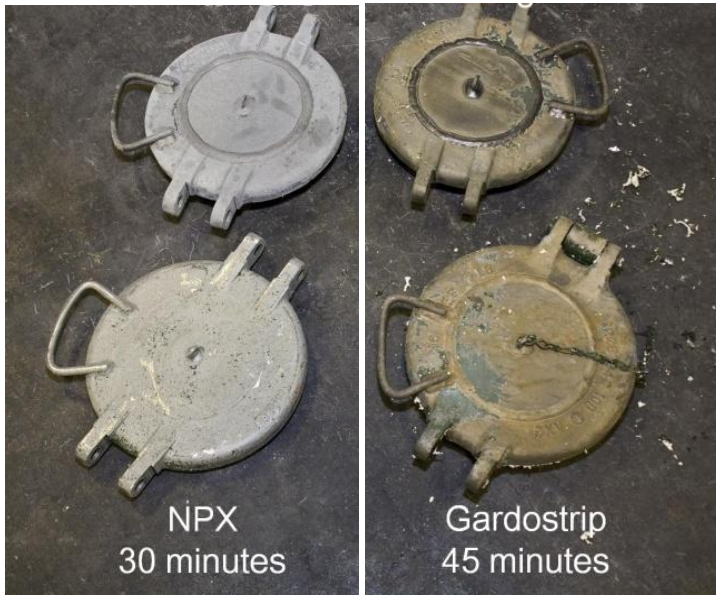
Building 409 NPX vs. Gardostrip



Filler opening caps coated with MIL-DTL-64159 or 53039 (tan/green exterior CARC)

Result: Parts stripped with Gardostrip required additional dwell time

CARC Coated Cupola

30 Minutes NPX

75 Minutes Gardostrip

3. Quantify HAP/VOC Reduction from Implementation of HAP-Free Alternatives

HAP and VOC Emissions Summary

Technology	HAP Emissions			VOC Emissions		
	lbs/yr	tons/yr	% Reduction	lbs/yr	tons/yr	% Reduction
NPX	250,993	125.5	--	107,568.25	53.78	--
D-Zolve 917	0	0	100%	12,134.07	6.07	89%
D-Zolve 298	0	0	100%	17,813.38	8.91	83%
Gardostrip Q7900A	0	0	100%	26,813.73	13.41	75%

Depainting Conclusions

- All HAP-free alternatives performed comparably to the NPX on what constitutes approximately 85% of ANAD's depainting workload
  - Longer dwell times required for parts with external chemical agent resistant coatings CARC (approximately 15% of the workload)
- All HAP-free chemical strippers are more cost effective than current NPX ($1.93M annual O&M) with annual O&M costs range from $1.29 to $1.51M
  - Greater savings realized compared to pollution control equipment ($2.45M annual O&M), which will be required for continued use of NPX
- Lowest cost option is D-Zolve 917 with payback for initial investment less than 6 months
- Replacement of NPX depainting operations would result in the elimination of HAP emissions and a 75-89% reduction in VOC emissions, depending on the solvent selected
- ANAD has implementing D-Zolve 917 in B114 and B409.

Background and Objective

Task 0527-A2: HAP-Free Vapor Degreasing for Critical Weapon Systems Applications

- EPA proposed Residual Risk standards under the NESHAP for Halogenated Solvent Cleaning (August 2006) to limit facility-wide emissions of perchloroethylene, trichloroethylene (TCE), and methylene chloride used in solvent cleaning
  - Over 90% of TCE use in the DoD is from ANAD
  - Current operations at ANAD include TCE vapor degreasing of small arms and miscellaneous components of combat vehicles
  - ANAD will be unable to comply with the proposed TCE limit without installing costly and burdensome pollution control devices
  - In order for alternatives to be implemented, the identified solvents and technologies require evaluation in accordance with critical engineering and performance requirements

Approach

Task 0527-A2: HAP-Free Vapor Degreasing for Critical Weapon Systems Applications

- Identify and downselect alternative degreasing/cleaning technologies for three applications of interest to ANAD
  - Degreasing (Building 409)
  - Removal of plating wax (Building 114)
  - Small arms cleaning/degreasing (Building 129)
- Conduct bench-scale testing on downselected alternatives
  - Vendor, commercial, and DoD locations
  - Evaluate alternatives as a method for removing Lubricant, Small Arms with Teflon (LSAT), cleaner lubricant preservative, grease, dirt/sand, carbon and powder residue, copper, lead, and brass fouling, plating wax, and other contaminants
- Up to two select technologies will undergo full-scale testing at ANAD

Technology Downselection

- Multiple technologies from 13 manufacturers/vendors were identified as potential solutions
- Product data was collected on various cleaning technologies from 13 manufacturers and solvent vendors
- The following 6 technologies, solvents, and/or systems were selected for and participated in the bench-scale technology demonstrations

Vendor	Product	Technology
Flo-Matic	No Chemical Cleaning System	Aqueous-based ultrasonic cleaning system
Police Products	Ultrasonic Weapon Cleaning System	Conventional cavitation ultrasonic system
Crest Ultrasonics	Dual-frequency Ultrasonic System	Custom dual-frequency ultrasonic system for wax removal
Better Engineering	F-4000-P using PDN-50	Industrial cabinet washer with an alkaline detergent
DuPont	Vertrel SDG	Hydrofluorocarbon (HFC)-based immersion vapor degreaser with ultrasonics
3M	HFE-72DE	Hydrofluoroether (HFE)-based immersion vapor degreasing (tested without ultrasonics)

Bench-Scale Test Results: Small Arms

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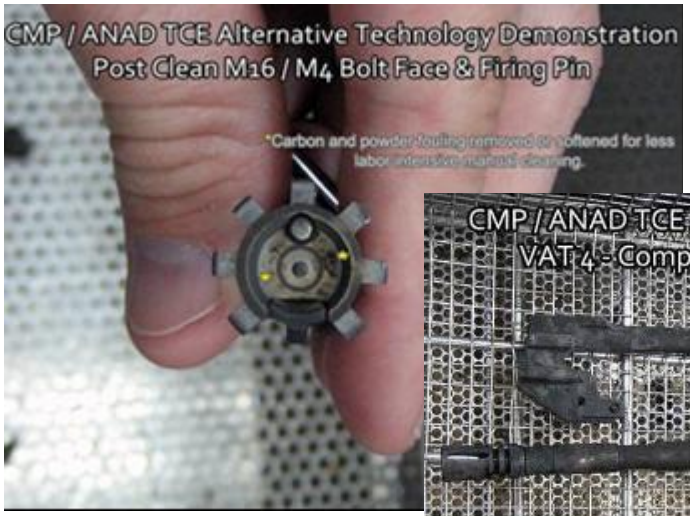
- Police Products Ultrasonic Weapon Cleaning System provided the best results for small arms degreasing (Building 129)
  - System tested at the Civilian Marksmanship Program (CMP) in Anniston, AL
  - Small arms parts were cleaned sufficiently after an 8-minute ultrasonic immersion in the first cleaning bath (ANAD max requirement is 30 min)
  - Police Products system degreases and cleans to a level acceptable by ANAD personnel and surpasses the performance of the TCE benchmark

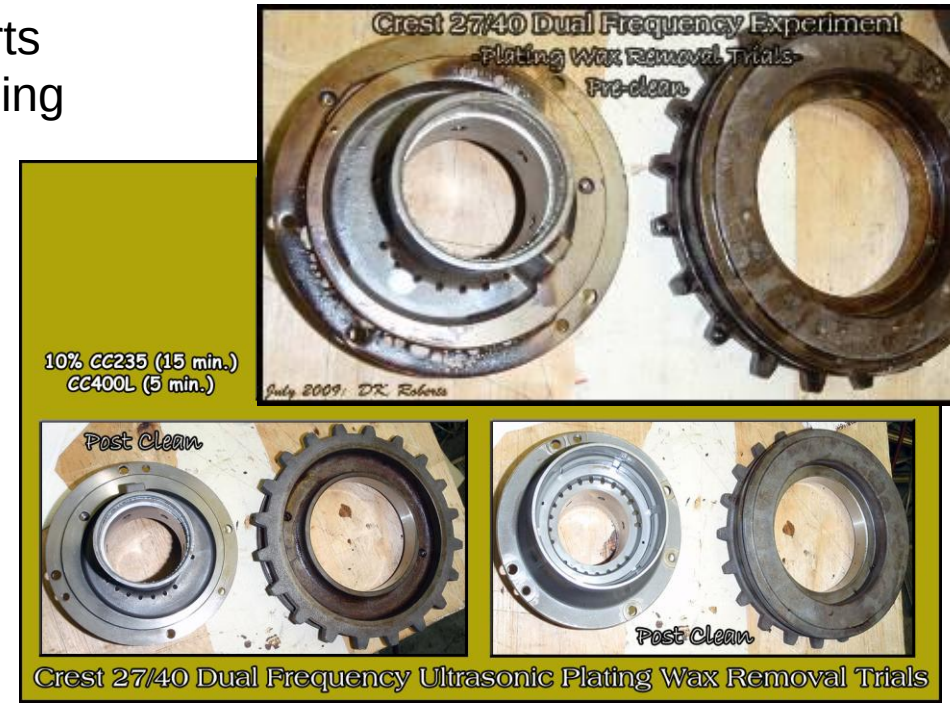
Police Products system at CMP



Small arms component following cleaning (left) and weapon prior to lube (below)

Bench-Scale Test Results: Plating Wax Removal

- Crest Ultrasonics Aqueous Dual-frequency Ultrasonic System provided the best results for plating wax removal (Building 114)
  - System tested at the Crest Ultrasonics facility in Trenton, NJ
  - Effective at removing heavy wax loadings
  - Secondary lube wash chemically dissolves remaining residues and leaves a light surface preservative to reduce oxidation potential while the parts staged for downstream processing



Parts Before and After Plating Wax Removal at Crest Ultrasonics

Bench-Scale Test Results: Degreasing

- Crest Ultrasonics Aqueous Dual-frequency Ultrasonic System and DuPont Vertrel SDG provided the best results for degreasing (Building 409)
  - Both systems/products were effective at degreasing the various vehicle components and should be considered for full-scale test and evaluation in an actual production setting

Above: DuPont Lab Cleaning Test Tank Interior
Right: Roller Bearings Before and After Testing

SPOTA Solvent Thrust Technical Review
ANAD TCE Alternatives Demonstration

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- Zenith ultrasonics
- Brulin 815GD and ChemCrest 235
- Small arms and wax removal systems installed

Summary

- NDCEE Task 527-A2 supported the full-scale test and evaluation of the small arms and plating wax alternatives at ANAD
- Alternatives have been implemented for small arms and plating wax applications

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